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NATIONAL DAM SAFETY PROGRAM. CEDAR GROVE WEST, NORTH, AND SOUTH--ETC(U)
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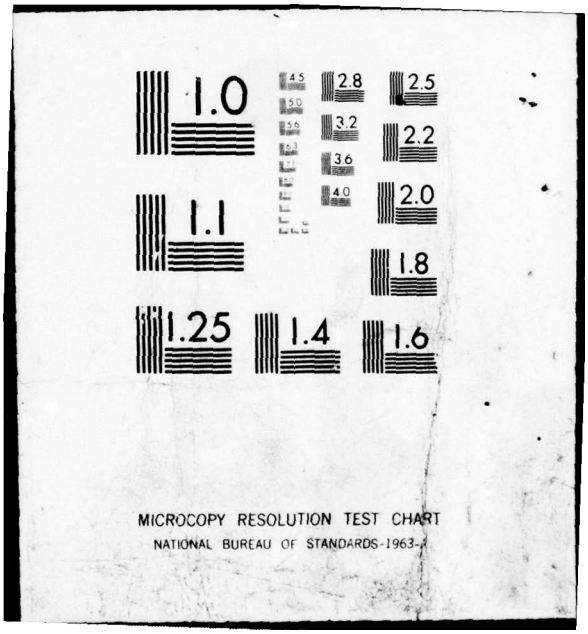
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PASSAIC RIVER BASIN

ESSEX COUNTY

NEW JERSEY

LEVEL II

CEDAR GROVE WEST, NORTH, AND SOUTH DAMS

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NJ 00392

NJ 00548

NJ 00549

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

JULY 1978

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NJ00392, NJ00548, NJ00549
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): Phase I Inspection Report
National Dam Safety Program
Cedar Grove West, North and South Dams
Essex County, New Jersey

5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL rept.
6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): (10) Rudolph J. Wahanik, P.E.

8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-78-C-0114

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Gilbert Associates, Inc.
P.O. Box 1489
Reading, Pa. 19603
(12) 78 p.

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer District, Philadelphia
Custom House, 2d & Chestnut Streets
Philadelphia, Pennsylvania 19106

12. REPORT DATE: (11) July 1978
13. NUMBER OF PAGES: 60

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

(6) National Dam Safety Program. Cedar Grove West, North and South Dams (NJ00392, NJ00548, NJ00549), Passaic River Basin, Essex County, New Jersey. Phase I Inspection Report.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
National Dam Safety Prgrgram
Dam Inspection Report Phase I
Cedar Grove West, North and South Dams, NJ.
Dams - N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

31 JUL 1978

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Cedar Grove North, West and South Dams in Essex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dams' conditions are given on the first two pages of the report.

Based on visual inspection, available records, calculations and past operational performance, the Cedar Grove Dams are judged to be in good condition. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Engineering studies and investigations to determine the overall structural stability of all three dams should be completed within one year from the date of approval of this report. Any remedial measures deemed necessary as a result of these studies and investigations should be initiated within calendar year 1979. Piezometers should be installed in the embankments of all three dams to furnish better data for the stability analysis and to serve as part of a safety related warning system, if such is necessary.

b. Within six months from the date of approval of the report, studies to evaluate the failed rip-rap slope of the South Dam should be completed. Repair of the failed rip-rap slope should be completed within one year from the date of approval of this report.

c. The following remedial works should be initiated within three months from the date of approval of the report and completed three months later:

(1) The surface drainage on the portion of the berm of the West Dam should be improved by regrading to avoid the

impoundment of surface water; the berm surface should be stabilized by adding granular subbase course.

(2) The entrance section of the twin concrete ducts of the spillway on the east end of the North Dam should be repaired. Debris accumulated in front of this intake should be removed.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Joseph Minish of the Eleventh District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,

Harry V Dutchyshyn

1 Incl
As stated

HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

Cy furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

ASSESSMENT OF GENERAL CONDITIONS

Name of Dam:	Cedar Grove West, North and South
State:	New Jersey
County:	Essex
USGS Quadrangle Sheet:	Orange, N.J.
Coordinates:	West Long. 40°51'43" Lat. E. 74°12'52"
	North Long. 40°51'54" Lat. E. 74°12'37"
	South Long. 40°51'12" Lat. E. 74°13'4"
Stream:	None
Date of Inspection:	May 31, 1978

The three dams that enclose the Cedar Grove reservoir are in good condition as defined in Appendix H.

It is recommended that:

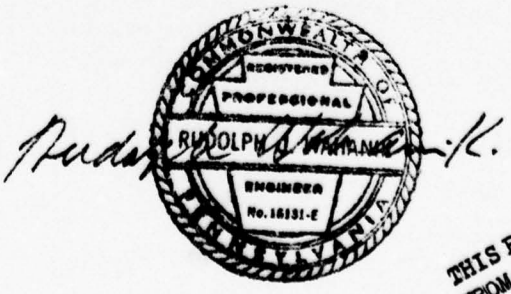
1. The failure areas on the South Dam be stabilized in the near future and the riprap be re-aligned, with inspection to be performed by a qualified engineer.

2. The surface drainage on the berm of the West Dam be improved in the near future to avoid impounding of water.

3. The entrance section of the twin concrete ducts of the spillway be repaired in the near future and the debris removed.

4. Piezometers be installed in the embankments of all dams to furnish basic data for stability analysis.

5. Foundation and material investigations be performed in the future to determine the engineering properties of the foundation soils and embankment materials as outlined in paragraphs 4.4.1, 4.4.2 and 4.4.2.1 of the U.S. Corps of Engineers, Recommended Guidelines for the Safety Inspection of Dams, (Appendix E).



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Based on visual inspection, available records, calculations and past operational performance, the Cedar Grove Dams are judged to be in good condition. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

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b. Within six months from the date of approval of the report, studies to evaluate the failed rip-rap slope of the South Dam should be completed. Repair of the failed rip-rap slope should be completed within one year from the date of approval of this report.

c. The following remedial works should be initiated within three months from the date of approval of the report and completed three months later:

(1) The surface drainage on the portion of the berm of the West Dam should be improved by regrading to avoid the impoundment of surface water; the berm surface should be stabilized by adding granular subbase course.

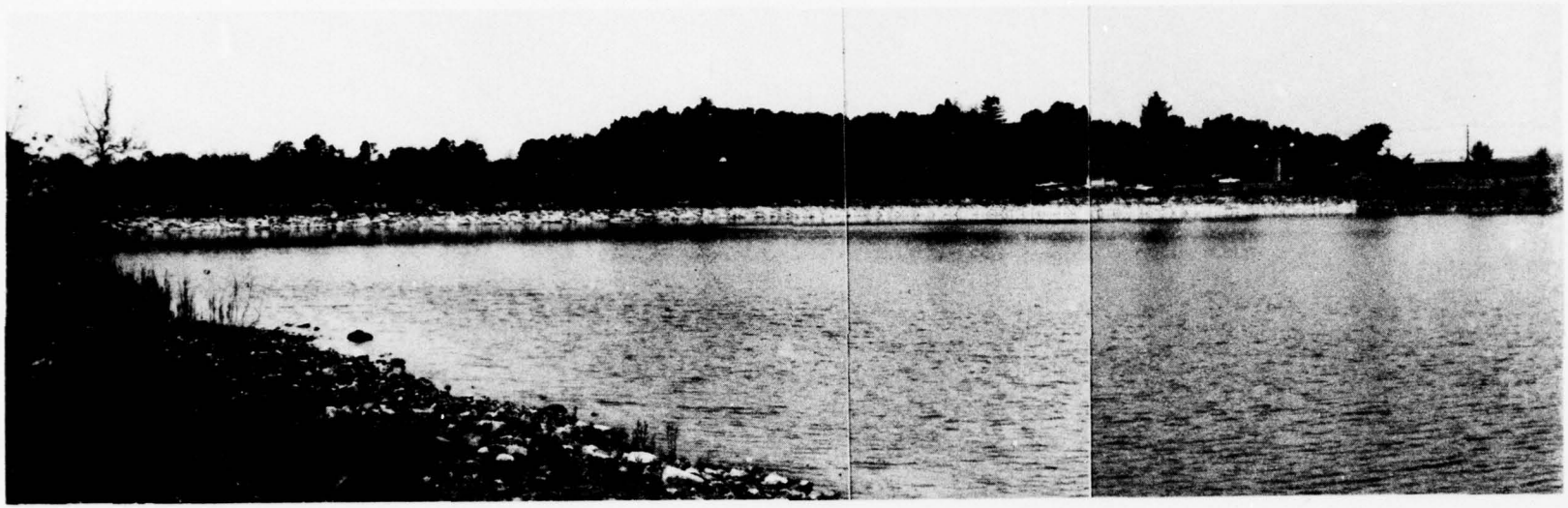
(2) The entrance section of the twin concrete ducts of the spillway on the east end of the North Dam should be repaired. Debris accumulated in front of this intake should be removed.

APPROVED: Harry V Dutchyshyn
HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

DATE: 31 July 1978

May 1978

WEST DAM
OVERVIEW FROM DOWNSTREAM



SOUTH DAM

May 1978

DOWNSTREAM VIEW OF
SOUTH DAM

May 1978

May 1978

UPSTREAM VIEW OF NORTH DAM

DOWNSTREAM VIEW OF
NORTH DAM

May 1978

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

TABLE OF CONTENTS

10

1.0 PROJECT INFORMATION

1.1 GENERAL

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-federal dams in the United States. Gilbert Associates, Inc. has entered into Contract No. DACW61-78-C-0114 with the Philadelphia Office of the U.S. Corps of Engineers to inspect this dam, Gilbert Work Order 06-7249-000.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the U.S. Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Reference 2), as modified by contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objective includes expeditiously identifying those dams which pose an immediate threat to human life or property and to recommend future studies and/or any obvious remedial actions indicated by the inspection.

1.2 PROJECT DESCRIPTION

1.2.1 Dam and Appurtenances: The Cedar Grove Dam is actually composed of three earthfill embankments, namely the North Dam I.D. No. NJ 00548, the West Dam I.D. No. NJ 00392, and the South Dam I.D. No. NJ 00549. The North Dam is about 36 feet high and 587 feet long; the West dam is about 55 feet high and 2590 feet long, and the South dam is about 34 feet high and 700 feet long.

All of these dams have concrete corewalls. The top of the West Dam is at elevation 410 feet; its concrete core extends from elevation 407.5 feet down to bedrock according to the record drawings. The tops of the North and South Dams are at elevation 411 feet and their concrete cores extend from elevation 408 feet down to bedrock according to the record drawings. The corewall of the South Dam extends 400 feet across Ridge Road (record drawing data).

The appurtenant structures consist of an outlet gate house distributing outflow water to the concrete conduit and tunnel, a regulator gate house regulating inflow water into the concrete conduit and inlet standpipe, and an overflow conduit and spillway.

1.2.2 Location: The dams are located about 2 miles north of Montclair, N.J. and at the border of Essex and Passaic Counties, in Cedar Grove Township. They lie on the First Watchung Mountain about 1.6 miles west of

the N.J. Garden State Parkway. Geologically, the dams are situated in an area underlain by Triassic basalt flow, which forms the First Watchung Mountain.

1.2.3 Size Classification: According to Section 2.1.1 of Reference 2, the dams are classified as intermediate structures because of their impoundments. The impoundments for the dams are:

North Dam	2297 acre-feet
West Dam	2584 acre-feet
South Dam	2233 acre-feet

1.2.4 Hazard Classification: The dams are surrounded to the north by Little Falls and West Paterson, to the west by Meadow Village, and to the south by Cedar Grove and Verona, with the west slope of the First Watchung Mountain to the east. The dams are classified as high hazard potential based on the requirements of Section 2.1.2 of Reference 2.

1.2.5 Ownership: The dams are owned and maintained by the City of Newark, Division of Water Supply. Engineering and maintenance facilities are located in Little Falls, Bergen County and water quality chemical laboratory is in Cedar Grove, Essex County. The address is:

City of Newark, Division of Water Supply
1294 McBride Avenue
Little Falls, New Jersey 07424

1.2.6 Purpose of Dam: The Cedar Grove North, West and South Dams were constructed to create a pumped storage reservoir against the west flank of the First Watchung Mountain. The reservoir supplies water to residents of Belleville, Bloomfield, the city of Newark, and the city of Elizabeth only during emergencies. The average yield of the reservoir is 75 MGD. The only sources of inflow into the reservoir are a 48-inch diameter aqueduct main and a 42-inch diameter aqueduct main that convey drinking water from the Charlotteburg water treatment plant 22 miles away. These two mains are combined into a single 60-inch pipe before entering the reservoir through the North Dam. The water originates in the Pequannock Watershed (63.7 square miles) and is initially stored in the Canister, Echo Lake, Clinton, Oak Ridge and Charlotteburg reservoirs. This information is noted on drawings received from the owner.

1.2.7 Design and Construction History: The Cedar Grove Reservoir Dams were designed and built by the East Jersey Water Company of Pittsburgh, Pennsylvania. Construction took place prior to 1904, the year the Cedar

Grove Reservoir was put into service (Reference 3). The New Jersey Department of Environmental Protection (DEP) has no data on the dams. The only item of subsequent construction or modification noted was a minor modification to the spillway area.

1.2.8 Normal Operational Procedures: The water level in this reservoir is maintained between elevation 395 feet and 405 feet MSL. The water volume stored is enough to supply a demand of 75 MGD for nine days. Water arrives at the reservoir through a 60-inch cast iron pipe; part enters the reservoir through the east regulator gate house, the remainder enters the reservoir through the 60-inch standpipe. Water leaves the reservoir through the west gate house, initially by means of a twin 60-inch conduit which becomes a 7-foot tunnel in rock. A 48-inch diameter drain from the West Gate House passes through the West Dam.

1.3 PERTINENT DATA

1.3.1 Drainage Area: Not applicable (pumped storage reservoir).

1.3.2 Discharge at the Dam Site: A 7-foot concrete tunnel, plus an 8-inch diameter steel pipe and a 48-inch diameter drain.

1.3.3 Elevation: (Feet above MSL)

Top of Dams: West dam 410 feet; North and South dams 411 feet.
Spillway Design Flood (SDF) Surcharge: 407.17
Full Flood Control Pool: Not applicable.
Recreation Pool: Not applicable.
Upstream Portion Invert Diversion Tunnel: Not applicable.
Downstream Portion Invert Diversion Tunnel: Not applicable.
Streambed at Centerline of Dams: North Dam - 375
West Dam - 355
South Dam - 377
Maximum Tailwater: Not applicable.

1.3.4 Reservoir:

Length of Maximum Pool - 4,900 feet.
Length of Recreation Pool: Not Applicable
Length of Flood Control Pool: Not Applicable

1.3.5 Storage (Acre Feet)

Recreation Pool: Not applicable.
Flood Control Pool: Not applicable.
SDF Surcharge: 2,290
Top of Dam: 2,584

1.3.6 Reservoir Surface (Acres:)

Top of Dam: 102
Maximum SDF Surcharge: 100
Flood Control Pool: Not applicable.
Recreation Pool: Not applicable.
Spillway Crest: 98

1.3.7 Dam:

Type - Earthfill with concrete corewall and similar clay puddle on upstream side from top of rock to original ground surface.

Length - North 587 feet - measured; 690 feet-record drawing.
West 2,590 feet - measured; 2,720 feet-record drawing.
South 700 feet - measured; 842 feet-record drawing.

Height - North 51 feet
West 90 feet
South 38 feet

Note: The heights noted are taken from the record drawings, and are the vertical heights from the bottom of the cut-off walls to the top of the dams.

Top Width - North 16 feet
West 18 feet
South 12 feet

Side Slopes - North 2 horizontal:1 vertical with 58-foot berm including roadway on downstream side
West 2 horizontal:1 vertical with 8-foot berm both sides, 50-foot berm on downstream side
South 2 horizontal:1 vertical with 52-foot berm including roadway on downstream side

Zoning - An impervious zone on the upstream side of the corewall, from top of rock to original ground elevation.

Top Elevation - North 386 feet
West 356 feet
South 388 feet

Impervious Core - Concrete corewall extending to reputedly solid rock

Top Elevation - North 408 feet (664 feet long)
West 407.5 feet (approximately 2,620 feet long)
South 407.5 feet (800 foot long dam crest plus 200 feet beyond dam)

Cutoff - A shallow cutoff into sound foundation rock is formed by the base of the concrete corewall.

Borrow: Borrow sources are shown on Figure 2.

Grout Curtain - None.

1.3.8 Diversion and Regulating Tunnel: Inlet water can be diverted from the 60-inch conduit through a 48-inch gate valve to the 7-foot rock tunnel.

1.3.9 Spillway: At the east end of the North Dam a twin concrete conduit with an invert elevation of 400 feet passes through the dam and under reservoir road to a spillway with a crest elevation of 405 feet.

1.3.10 Regulatory Outlet: The West Gate House contains 12 sluice gates, eight placed in pairs, and four placed singly. Lake water enters the structures through six arched openings, placed in pairs at elevation 359.9 feet, elevation 369.9 feet, and elevation 389.9 feet. Water leaves the West Gate House through two 48-inch cast iron pipes which merge into a 60-inch concrete conduit leading to the tunnel. Two 48-inch cast iron pipes change to a single 60-inch cast iron pipe leading to the North Dam.

A 48-inch cast iron pipe with an invert elevation of 353.9-feet is located in the base of the West Gate House to drain the basin.

2.0 ENGINEERING DATA

2.1 DESIGN

Design data were not available at the Newark Division of Water Supply and the N.J. Department of Environmental Protection (DEP).

2.2 CONSTRUCTION

A few sets of record drawings showing cross-sections, profiles, and plans are available at the Newark Division of Water Supply's Office, Little Falls, N.J. No other information was available for use in this Phase I inspection. Cross-sections through the dams are shown in Figures 2, 3 and 4.

2.3 OPERATION

There are no flood control operations at this dam. Water from this reservoir covers the demand of the supply system. Under normal conditions, the water flows by gravity through the upland supply aqueduct (Charlotteburg Reservoir). Under emergency conditions water can be supplied to the aqueduct and to Cedar Grove by pumping up to 25 MGD from the Wanaque Aqueduct System through the Belleville bypass.

2.4 EVALUATION

2.4.1 Availability: Foundation and material data, and engineering design analysis data are not available.

2.4.2 Adequacy: The available record drawings appear to be adequate.

2.4.3 Validity: The record drawings appear to be consistent with existing structures.

3.0 VISUAL INSPECTION

3.1 FINDINGS

3.1.1 General: The Phase I dam inspection was performed on May 31, 1978 by a team of engineers from Gilbert Associates, Inc. An employee of the city of Newark, Division of Water Supply, accompanied the inspection team to provide access to the East and West Gate Houses. Findings are as follows.

3.1.2 Dam: Surface cracks and unusual movement or cracking at or beyond the toe were not observed for the West, North and South Dams. The downstream slopes of all the dams were fully covered by grass except the roadway on the crest and the vehicle tracks on the berm of the West Dam.

The upstream side of the top of the South Dam appears to have settled slightly since construction, as has the upper portion of the riprap slope of the South Dam. No slope distress was found on the West and North Dams. Some vegetation was found growing in the riprapped slopes of all three dams.

A minor wet area was noted on the downstream berm about 676 feet from the south end of the West Dam. No significant seepage condition was observed throughout the downstream slopes and at any of the toe areas. The wet area is shown in Appendix C.

3.1.3 Appurtenant Structures: (a) Spillway - The only spillway for the reservoir is located at the east end of the North Dam. The entrance portion of the twin concrete ducts has been badly damaged, and is partially blocked by debris. The twin 28.5-inch high by 56-inch wide ducts are still serviceable. The spillway section itself appears in good condition, and has been modified since the record drawing was made in 1905.

(b) The outlet gate house along the West Dam appears to be in good repair, with its travelling screens and sluice gates in operating condition. The submerged section, constructed of rubble masonry with cut stone facing, appears to be in good condition.

3.1.4 Reservoir Area: The gentle natural slopes and riprap-paved embankment slopes appeared to be in a stable condition during the visual field inspection, except as noted for the South Dam.

3.2 EVALUATION

The West and North dams showed uniform, smooth, and well-protected embankment slopes, the crest of the dams had good alignments, and critical signs of distress were not observed. It can be said that the West and North

dams proper were visually in good condition. Nevertheless, the intake structure of the overflow spillway at the east end of the North Dam needs to be repaired because of extensive damage. Some wet areas on the berm of the West Dam were believed to be related to the poor surface drainage. This condition could be corrected by regrading and stabilizing the berm surface with granular material.

The dislodged and disturbed riprap on the upper portion of the upstream slope of the South Dam was apparently caused by a slope failure or movement of the embankment. This condition should be further studied to evaluate the stability of the dam and to recommend corrective measures.

3.3 ATTENDEES

Gilbert Associates, Inc.

Rudolph J. Wahanik
Fine T. Hsu
Rudi P. Visser

4.0 OPERATIONAL PROCEDURES

4.1 PROCEDURES

The water level in the Cedar Grove Reservoir is dependent on the amount being pumped in, on the demand of its users, and on the temperature. The maximum high water level permitted by the spillway's crest is elevation 405 ft and the maximum allowable water level fluctuation during normal conditions is 10 ft or down to elevation 395 ft.

4.2 MAINTENANCE OF DAM

The dam sections of the reservoir can be travelled by car, and the gravel road along the tops of the dams are well maintained. The reservoir site is completely surrounded by a security fence; the main gate on Ridge Avenue seems to be open and unattended most of the time, and the fence has been breached in several locations, apparently by swimmers. Maintenance of the dam seems to consist of mowing the grass slopes. The mower has caused some rutting of the west berm of the West Dam, resulting in some ponded water on the berm. The toe areas of all three dams are covered with a dense growth of trees.

4.3 MAINTENANCE OF OPERATING FACILITIES

All visible parts of the travelling screens, sluice gates, etc., in the West Outlet Gate House seemed in good repair despite of the age of the equipment.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

As far as could be determined, no automatic warning system exists at this dam.

4.5 EVALUATION

The maintenance procedures for this dam seem to be adequate. However, some maintenance work is required on the South Dam where the riprap and supporting embankment have settled.

5.0 HYDRAULIC/HYDROLOGIC DESIGN

The hydrologic analysis presented in this report and in Appendix D pertains to present hydrologic conditions and does not consider future changes produced by uncertain conditions such as urbanization, forest fires or other modifications within the watershed.

5.1 EVALUATION OF FEATURES

Cedar Grove Reservoir has no upstream drainage area; the drainage area is simply equal to the reservoir surface area. This means that the probable maximum flood (PMF) inflow hydrograph is equal to the probable maximum storm (PMS) falling on the reservoir surface. The PMS rainfall depths for this area is 27 inches (Reference 5).

The reservoir pool elevation during normal operation is maintained between 395 and 405 feet MSL. The spillway overflow structure is in poor condition and has its crest at elevation 405 feet. The tops of the dams are located at 410 feet and 411 feet with impermeable cores up to 409.5 feet. These dams are not overtopped by the PMS, even if the outlet structure did not function at all. This reservoir is essentially free from danger caused by flooding.

5.2 RESERVOIR DRAWDOWN

If an emergency condition occurs, that affects the stability of one of the several dams that form the Cedar Grove Reservoir, then a fast drawdown of the reservoir to a lower water level may be required. The lower water level which would be required depends on the location and nature of such a postulated hazardous condition. The water stored in the reservoir can be lowered by means of a 48-inch diameter concrete conduit, 1370 feet long installed beneath the West Dam. Flow through the 48-inch diameter drain conduit is controlled by means of a gate valve installed in the reservoir's West Gate House. The center line of the conduit is located at approximately elevation 355 feet.

The time required to drawdown 2,083 acre-feet from elevation 405 feet to elevation 355 feet was calculated under the assumption that the water inflow from the aqueduct has been shutoff and that the 48-inch diameter drain conduit has a Manning's n = 0.024.

The drawdown times required to evacuate the storage volume thru the 48-inch diameter drain alone and in conjunction with an average system demand of 75 MGD are:

Water Elevation	Reservoir* Storage	Total Reservoir Drawdown Time	
		48-Inch Drain Alone	48-Inch Drain Plus Water Demand
ft.	Acre-ft.	Hours	Hours
405	2,083	0	0
400	1,637	39	39
395	1,230	78	77
390	882	112	112
385	618	141	140
380	442	161	160
375	297	180	179
370	182	197	195
365	98	211	210
355	0	238	236

* The Cedar Grove Reservoir capacities used were supplied by Mr. Jim Conley, Associate Civil Engineer of the City of Newark, Division of Water Supply. The reservoir capacities as well as the drawdown calculations are in Appendix D.

6.0 DAM STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

6.1.1 Visual Observation: The embankments of the West and North Dams were in good condition (see Appendix H) and have no critical signs of distress. However, the partial failure of the upstream riprap slope of the South Dam indicates that further investigation and analysis of its slope stability will be required. The rocks exposed in the vicinity are chiefly hard and dense fine-grained basalt with two sets of vertical conjugated joints.

6.1.2 Design and Construction Data: Structural stability analysis data are not available for review. Because of lack of necessary foundation and material information, an adequate and valid structural stability analysis of the South Dam cannot be made at this time.

6.1.3 Operating Records: The embankments were reported in good condition during the previous operating years. The reservoir water level has been regulated through the pipeline system, gates, and overflow structures without overtopping history.

6.1.4 Post-Construction Changes: The current spillway is different from the record drawing.

6.1.5 Seismic Stability: Although this dam is located within Zone 1 on the Algermissen's Seismic Risk Map of the United States (1969 edition), there are questions with respect to the static stability of the South Dam, as set forth in paragraph 6.1.1, and, therefore, in accordance with paragraph 3.6.4 of Reference 2, no assumptions can be made as to the seismic stability of the South Dam. Observation of the West and North Dams indicates satisfactory static stability and conventional safety margins, and, therefore, in accordance with paragraph 3.6.4 of Reference 2, these dams may be assumed to present no hazard from earthquake motions.

7.0 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

The assessment and remedial measures made are subject to the Conditions contained in Appendix H.

7.1.1 Safety: The visual inspection of the West and North Dams revealed the dams to be in good condition. No positive signs of distress such as slope failure, embankment cracking, noticeable differential settlement, or excessive seepage and erosion were found in these dams. The South Dam is in good condition except for some minor settlement in one location of the top of the dam and partial failure of the upstream riprapped slope have developed. As the partial failure of the riprap slope of the South Dam might develop with time into a safety hazard, a further investigation and analysis of slope stability of the South Dam is recommended.

Since there is no direct or indirect runoff contribution from the surrounding watershed into the reservior and the maximum operating level is well below the crest of the dams, the water volume resulting from the PMS will not overtop the crest of the dams or endanger their stability.

7.1.2 Adequacy of Information: The outer geometry of the dams as shown in the record drawing was verified by the visual inspection. Subsurface and embankment material data to be used in evaluating the stability of the dams is not available.

7.1.3 Urgency: Studies and remedies are needed in the future.

7.1.4 Necessity for Further Studies: Further studies are needed to evaluate the failed riprap slope of the South Dam and overall structural stability of all three dams - West, North and South Dams. Studies needed are borings, testing and analyses as outlined in paragraphs 4.4.1, 4.4.2, and 4.4.2.1 of the U.S. Corps of Engineers, Recommended Guidelines for the Safety Inspection of Dams (Appendix E). Piezometers should be installed in the embankments of all dams to furnish basic data for stability analysis, and/or to serve as a part of a safety related early warning system.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

7.2.1 Alternatives: No alternatives to the studies outlined in paragraph 7.1.4 have been identified. Riprap on the upstream face at the South Dam should be realigned, and the failed slope inspected by a qualified engineer after the repairs have been made.

7.2.2 Operational/Maintenance Procedures: The surface drainage on the portion of the berm of the West Dam should be improved by regrading to avoid the impoundment of surface water; the berm surface should be stabilized by adding granular subbase course.

The entrance section of the twin concrete ducts of the spillway on the east end of the North Dam should be repaired. Debris accumulated in front of this intake should be removed.

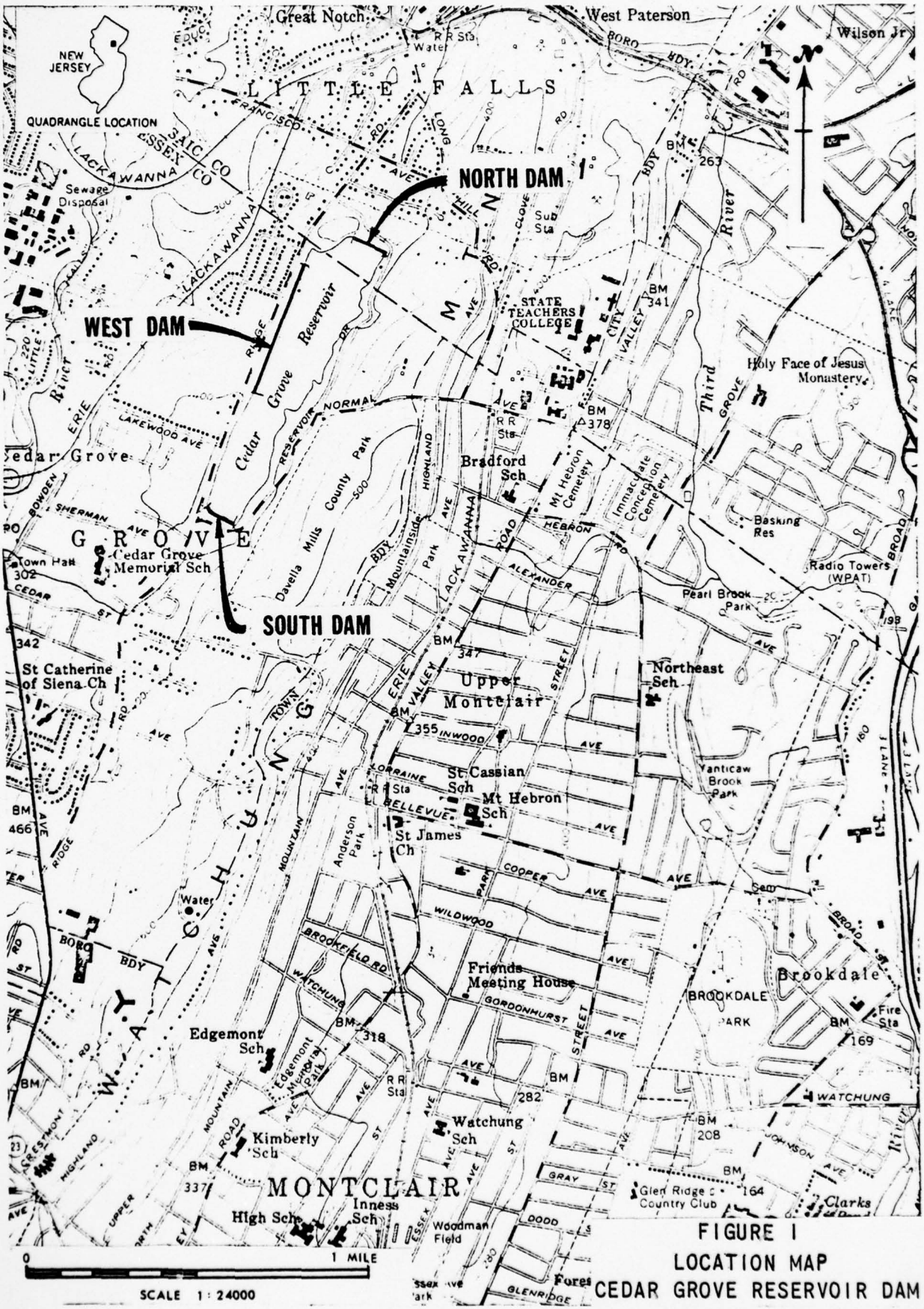
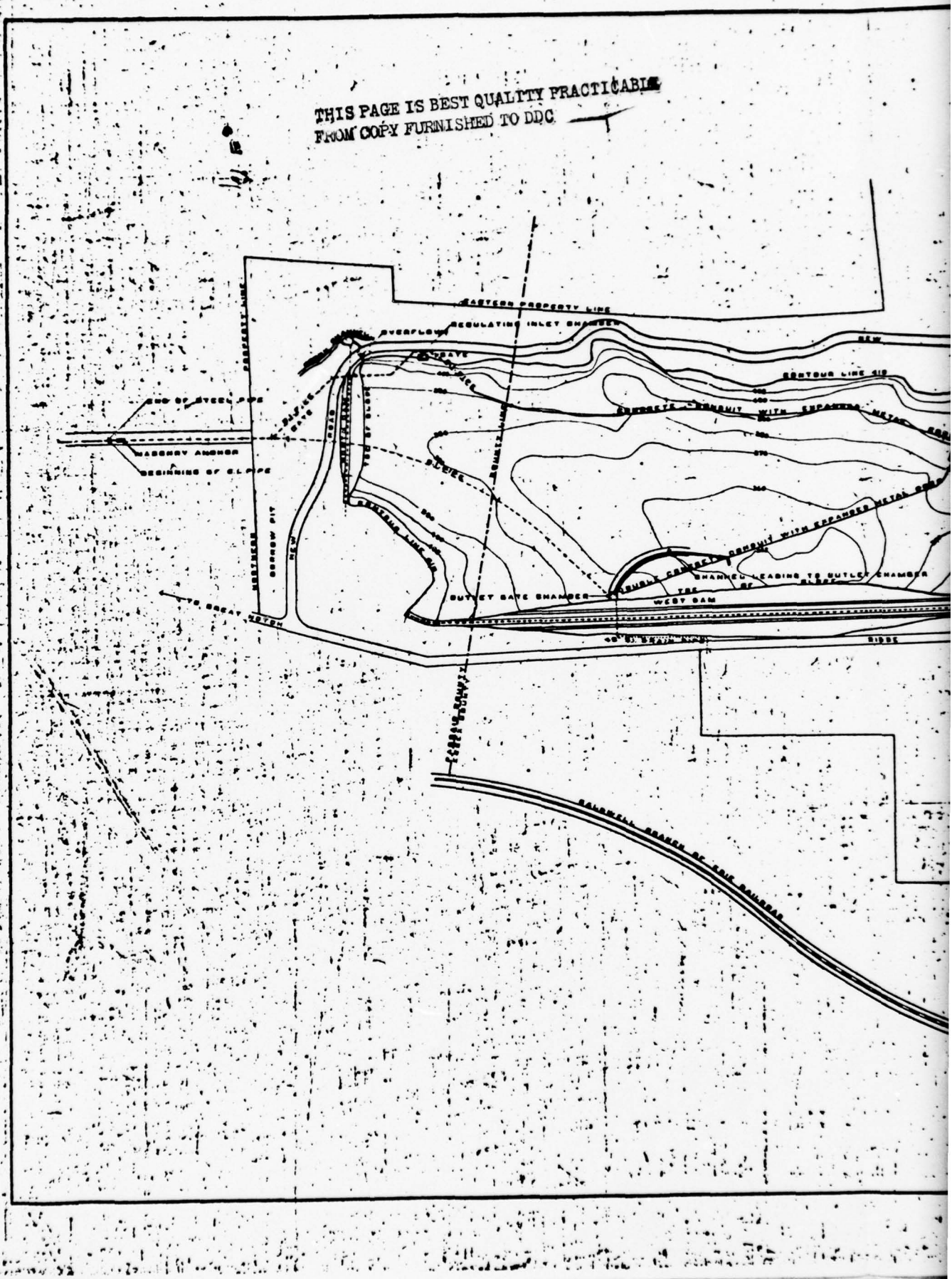


FIGURE 1
LOCATION MAP
CEDAR GROVE RESERVOIR DAM



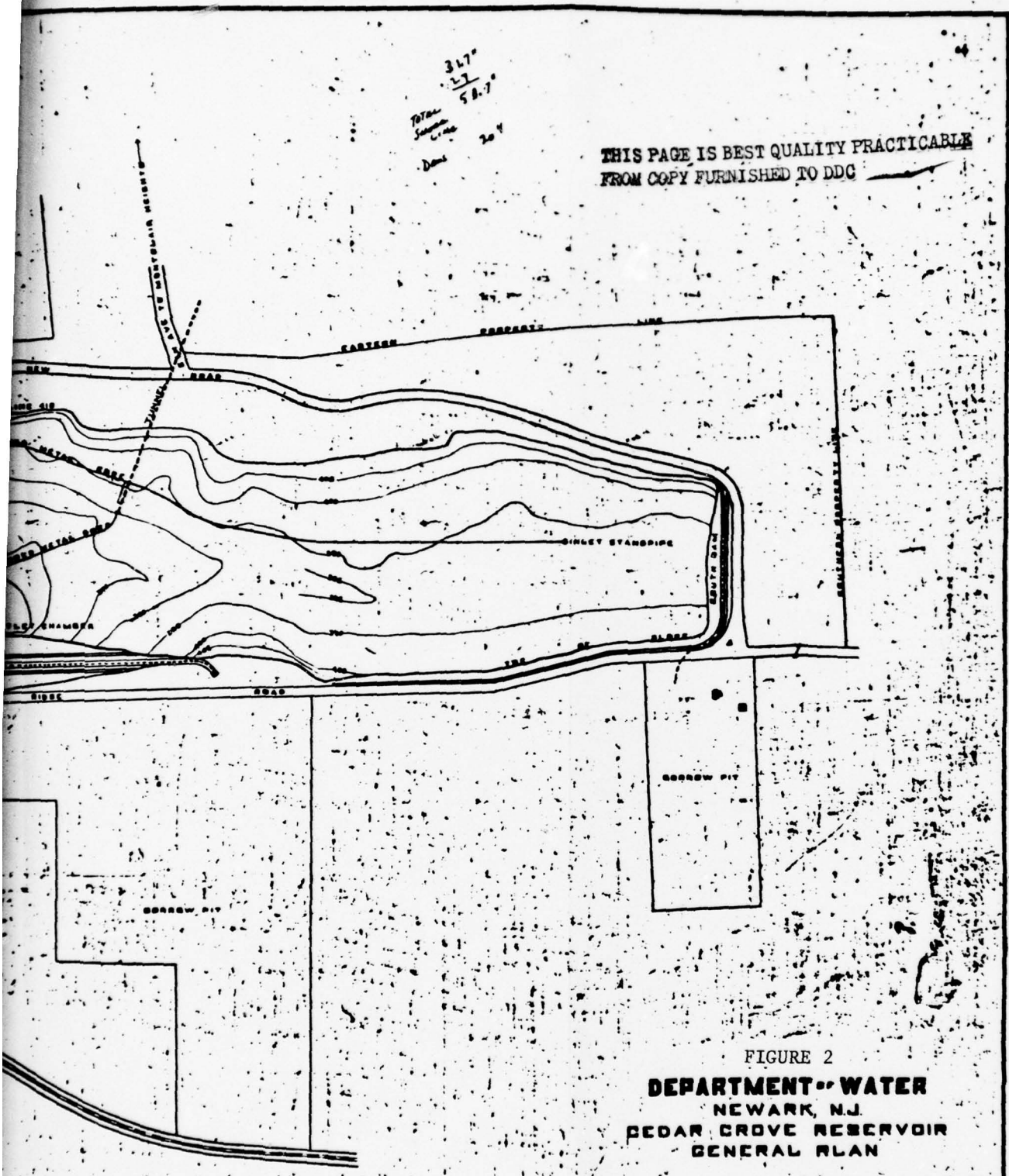


FIGURE 2

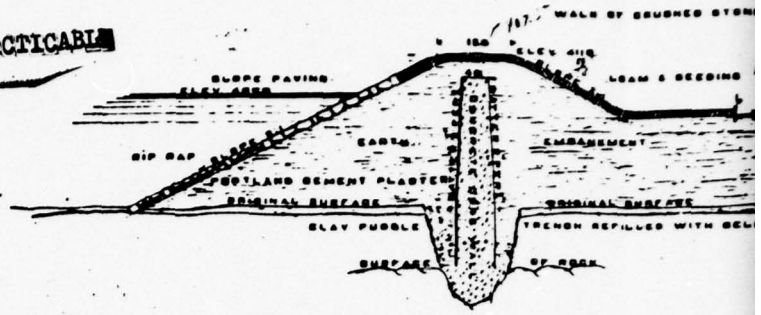
DEPARTMENT OF WATER
NEWARK, N.J.
CEDAR GROVE RESERVOIR
GENERAL PLAN

M. R. Sheinard
CHIEF ENGR.

SCALE 200'-1"

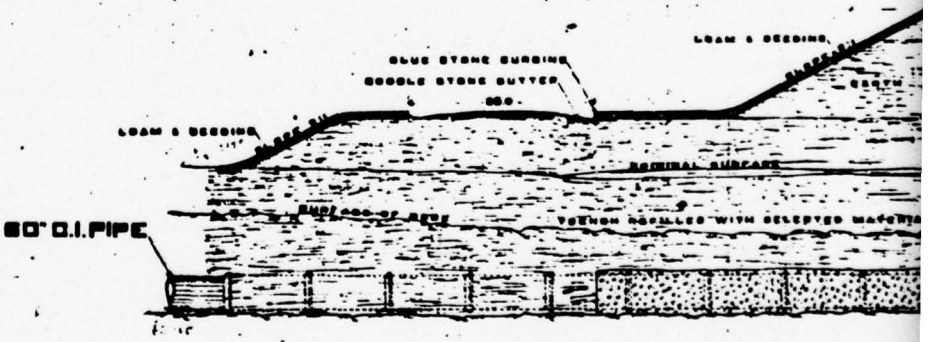
RECORD DRAWING
AUG 1903

CASE 2 PKT 8 FLDR 4 FILE 30CGACC.223



SECTION of SOUTH DAM

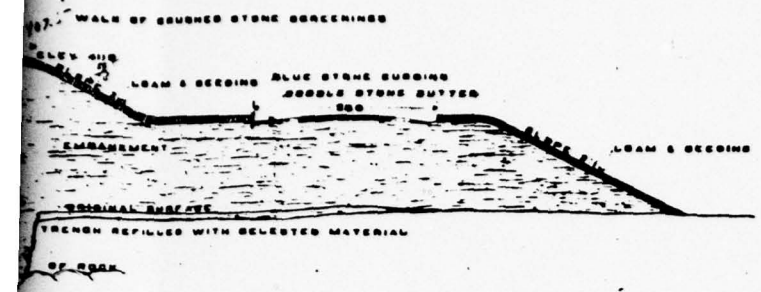
PROFILE of SOUTH DAM



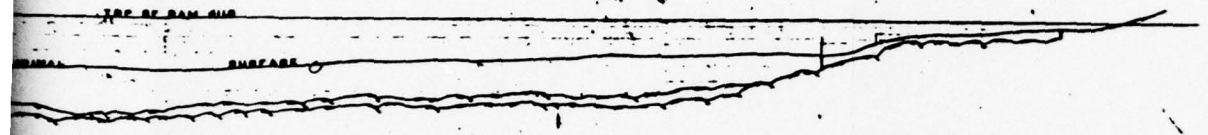
SECTION of NORTH DAM

PROFILE of NORTH DAM

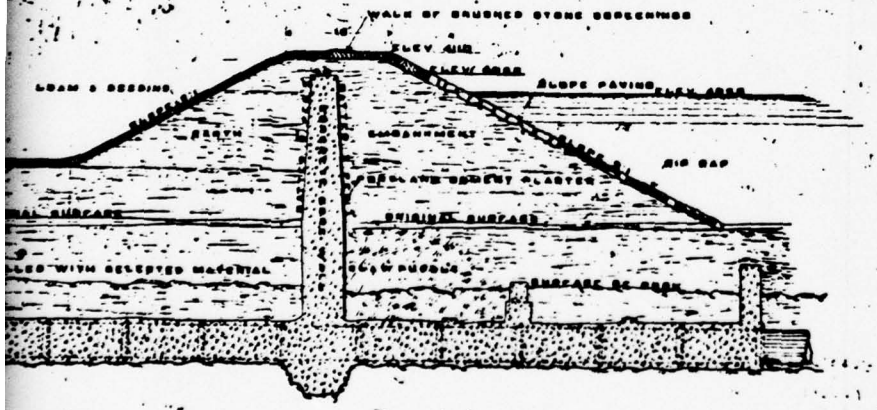
SCALE 1 IN-



H DAM SCALE 1 IN-10 FT



H DAM SCALE 1 IN-30 FT



TH DAM SCALE 1 IN-10 FT

SCALE 1 IN-30 FT

FIGURE 3

DEPARTMENT OF WATER
NEWARK, N.J.
CEDAR GROVE RESERVOIR
PROFILE—SECTION—NORTH—SOUTH DAM

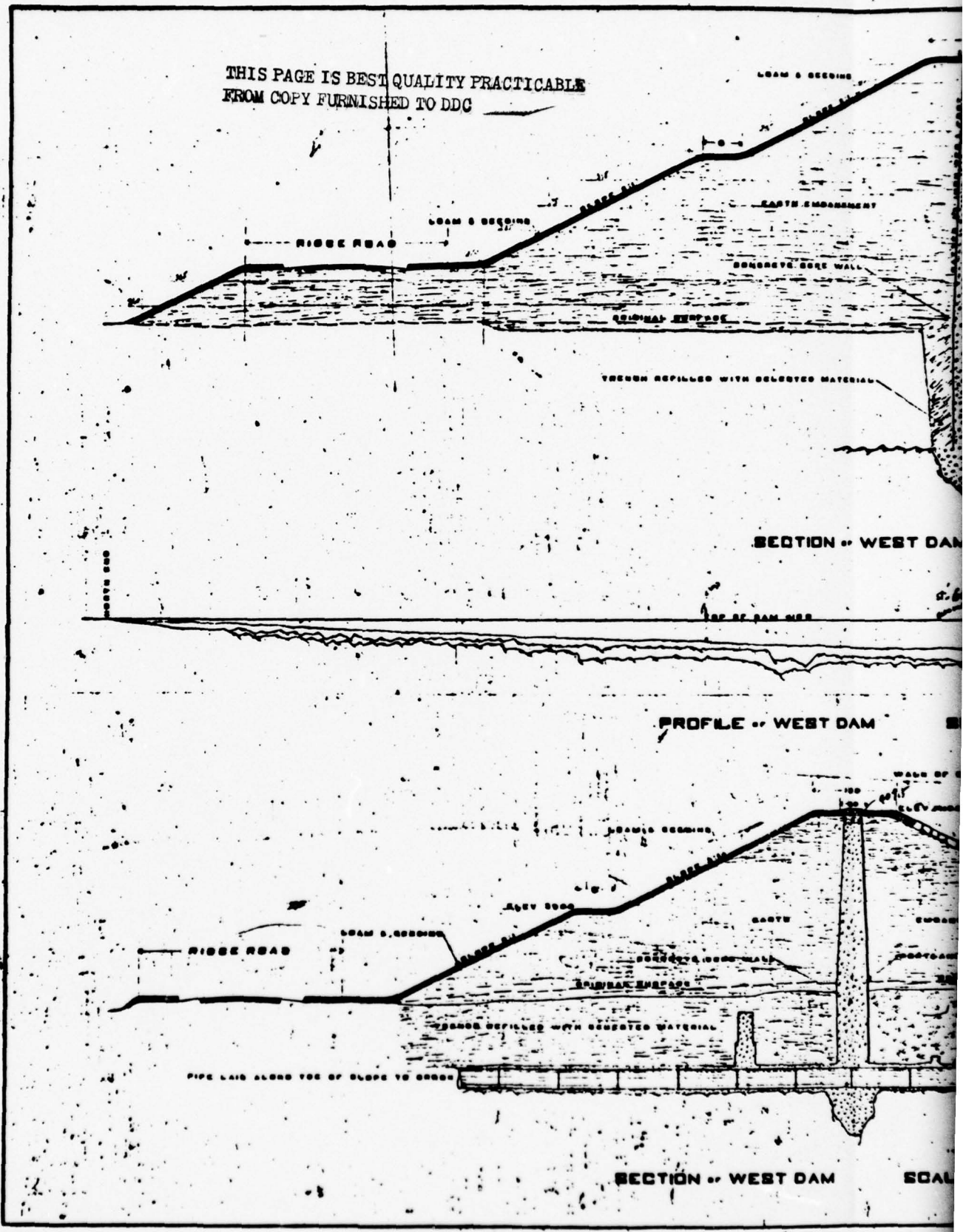
ENGR & SUPT

RECORD DRAWING
AUG. 1905

3 2.

CASE 2 PKT 5 FLDR 4 FILE 30 CG ACC. 228

2



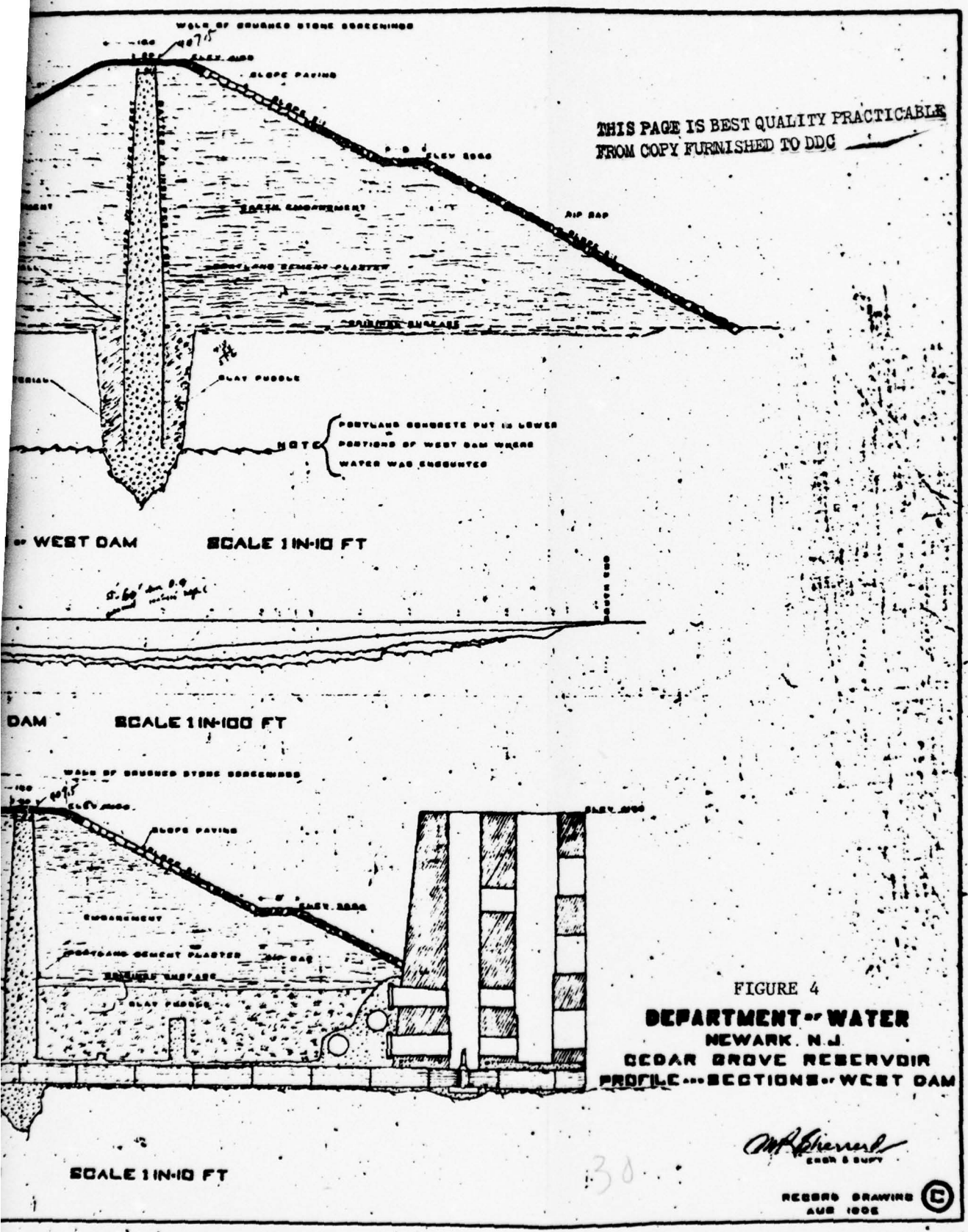
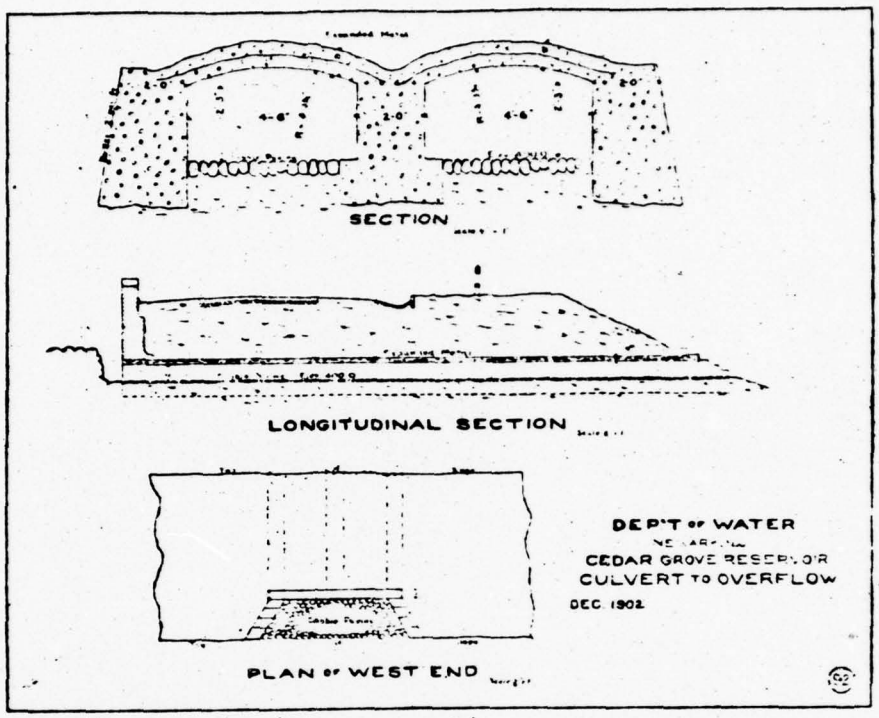


FIGURE 4

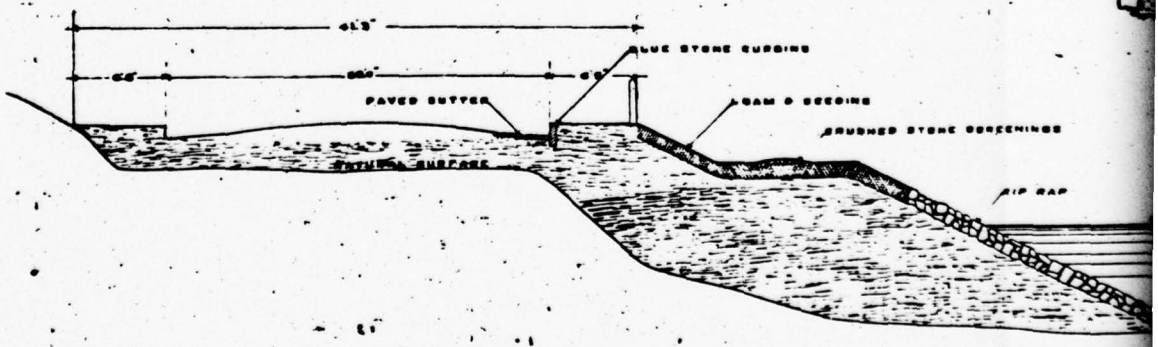
DEPARTMENT OF WATER
NEWARK, N.J.
CEDAR GROVE RESERVOIR
PROFILE --- SECTIONS OF WEST DAM

ENGR & SUPT

RECORD DRAWING
AUG 1906

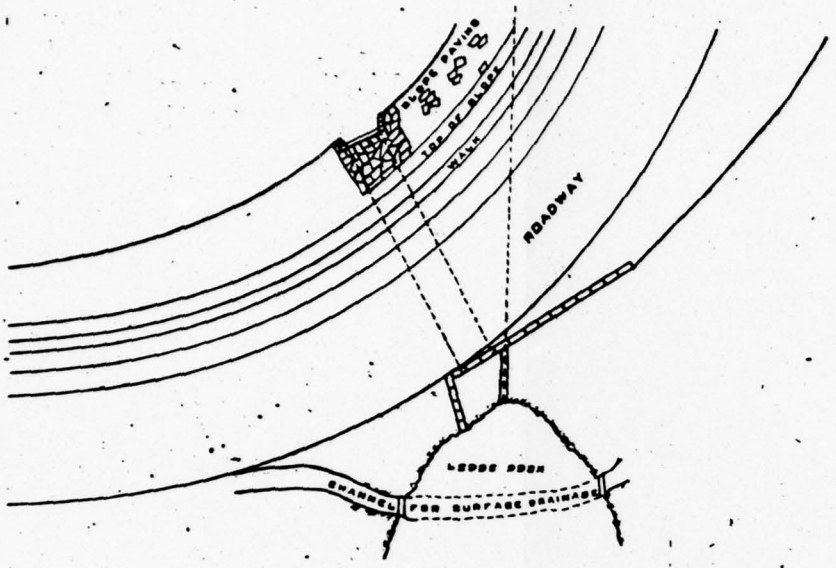


CASE & PMT B FLDR 1 FILE 30CC ACC 577

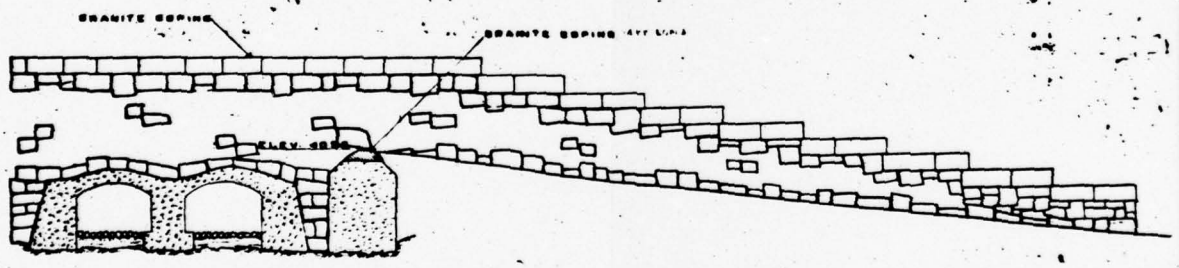


SECTION OF RIDGE ROAD (EARTH FILL)

SCALE 5 FT=1 IN



OVERFLOW SCALE 20 FT=1 IN



SECTION OF SPILLWAY SCALE 1/4 IN=1 FT

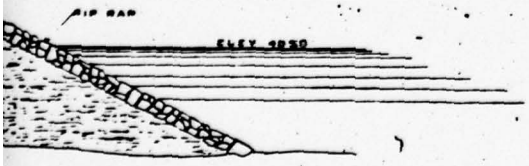


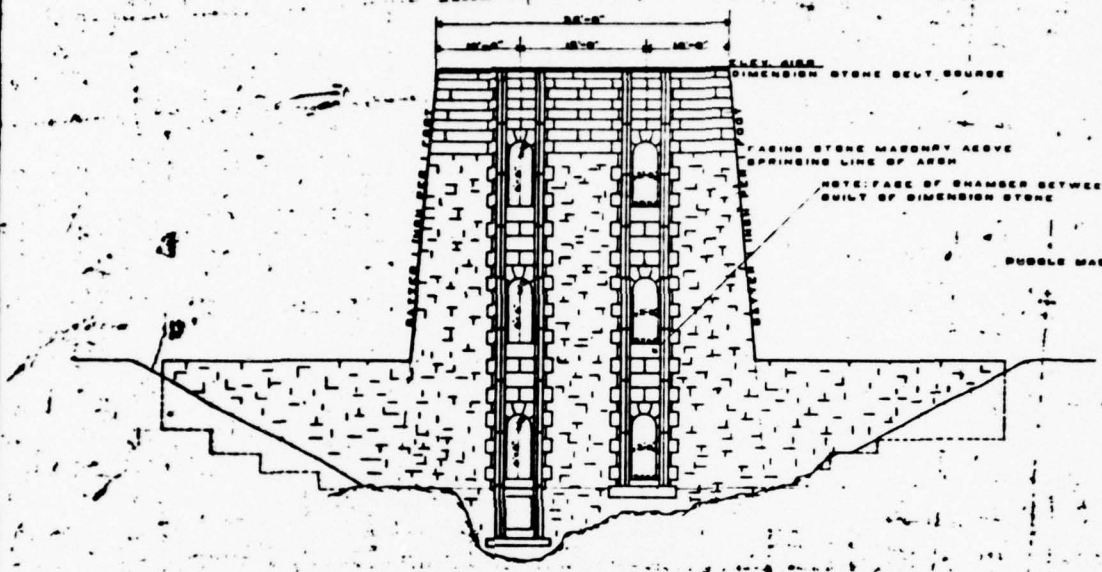
FIGURE 5

DEPARTMENT OF WATER
NEWARK, NJ
CEDAR GROVE RESERVOIR
ROAD SECTIONS AND OVERFLOW

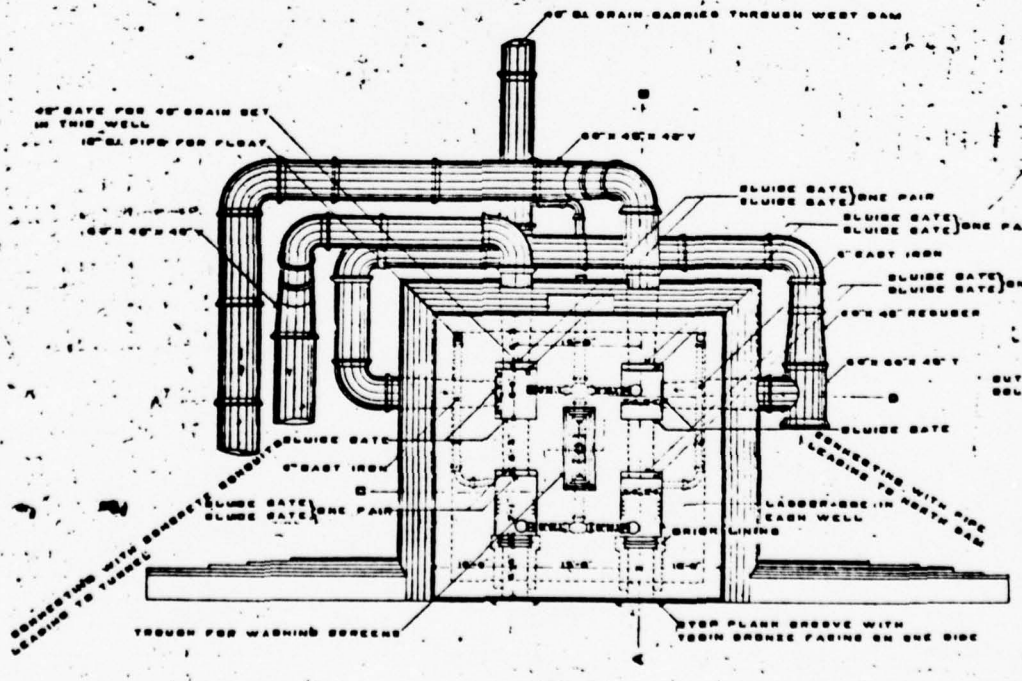
M P Sherard
ENGR SUPT

RECORD DRAWING
AUG. 1905 (H)

2 - 3 - 2
CASE 2 PKT 8 FLDR 4 FILE 30CG ACC. 230



ELEVATION



PLAN

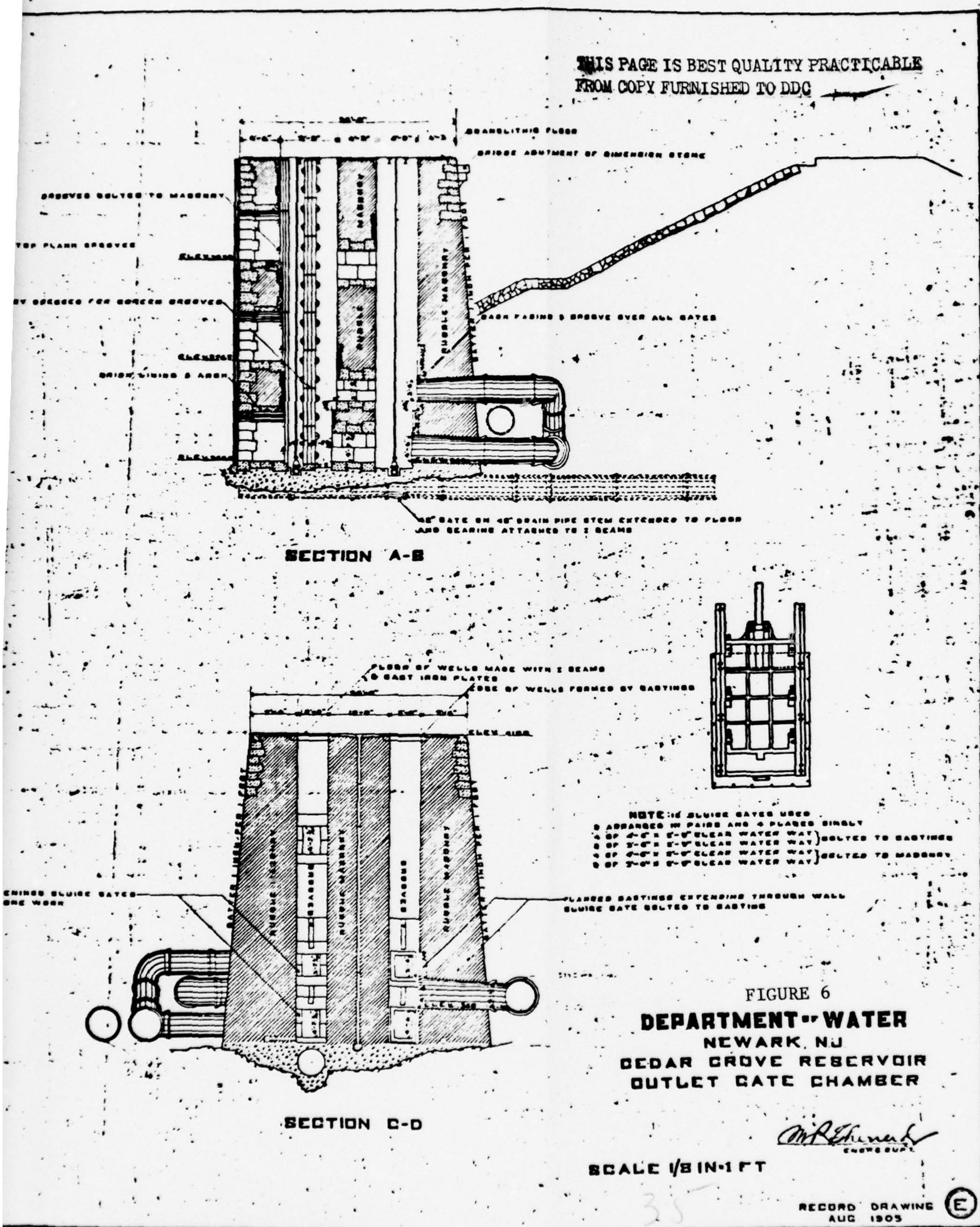


FIGURE 6

APPENDIX A

VISUAL CHECK LIST

Check List
Visual Inspection
Phase 1

Name Dam: Cedar Grove County: Essex Co. and Passaic Co State: New Jersey Coordinators: Corps of Engineers Philadelphia District

Date of Inspection: May 31, 1978 Weather: Bright and Sunny Temperature: 80°F

Pool Elevation at Time of Inspection 401.3 MSL Tailwater at Time of Inspection Not Applicable

Inspection Personnel:
Gilbert Associates, Inc.

Rudolph J. Wahanik

Fine T. Hsu

Rudi P. Visser

Others:
None

Recorder: Fine T. Hsu

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not Applicable	
STRUCTURAL CRACKING	Not Applicable	
VERTICAL AND HORIZONTAL ALIGNMENT	Not Applicable	
MONOLITH JOINTS	Not Applicable	
CONSTRUCTION JOINTS	Not Applicable	
SEE PAGE ON LEAKAGE	Not Applicable	
STRUCTURES TO ABUTMENT/ EMBANKMENT JUNCTIONS	Not Applicable	
DRAINS	Not Applicable	
WATER PASSAGES	Not Applicable	
FOUNDATION	Not Applicable	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	Several burrow holes were suspected on the lower berm inside the security fence along the west dam.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Slight sloughing was occasionally observed near the toe of the central section of the west dam. Sloughing or erosion was not seen on the embankment slopes of the north and south dams. All downstream embankment slopes above the roadway were adequately covered by grass. Dense trees cover the toe area of the west and north and south dams.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	The two sides of the crest of the south dam appear to have settled relatively uniformly after construction. The crest of the west and north dams are in proper alignment.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RIPRAP FAILURES	Some riprap along the upper half of the upstream slope of the south dam was dislodged and pushed or squeezed out. The riprap slopes of the west and north dam are in good condition.	The failure of riprap slope of the south dam needs further study to determine the cause of the failure and corrective measures.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	All junctions of embankment and abutment, spillway and dam appear to be in good and normal condition.	
ANY NOTICEABLE SEEPAGE	None	A wet area (shown in photographs, Appendix C) was located on the berm about 676 feet from the south end of the West Dam; the wet condition was probably caused by poor surface drainage of the berm which was altered by the use of the large mower along the berm causing rutting.
STAFF GAGE AND RECORDER	Automatic gage with float inside west outlet gate building - Reservoir elevation was 401.3 at 10 a.m. at time of inspection.	
DRAINS	The 48-inch drain pipe laid through the base of the west dam was not operating from the outlet gate house. A 24-inch cast iron pipe across the roadway along the lower berm of the west dam was not visible due to dense vegetation around the toe area.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None	
INTAKE STRUCTURE	a. Regulator gate house on east shore - water flows into reservoir over concrete apron. b. Inlet standpipe 350 feet offshore - consists of 60-inch cast iron pipe mounted vertically - could not be inspected.	Neither of these structures is connected with any of the dams enclosing the reservoir.
OUTLET STRUCTURE	West Outlet Gate House - sluice gates and associated piping could not be inspected, due to the height of the water in the structure.	
OUTLET CHANNEL	Not visible.	The 48-inch drain pipe from the West Gate House daylights in the outlet channel across Ridge Road. The channel was filled with tree trimmings and miscellaneous debris. However, no flow was discernible in the channel.
EMERGENCY GATE	Not Applicable	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The concrete spillway with granite weir near east end of north dam is in good condition. The inlet of the twin concrete ducts to the spillway is in poor shape.	
APPROACH CHANNEL	Not Applicable	
DISCHARGE CHANNEL	Not Applicable	
BRIDGE AND PIERS	Walkway connecting west outlet gate house to west dam is 62 feet long, and in good condition.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not Applicable	
APPROACH CHANNEL	Not Applicable	
DISCHARGE CHANNEL	Not Applicable	
BRIDGE AND PIERS	Not Applicable	
GATES AND OPERATION EQUIPMENT	Not Applicable	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	There are approximately eight bench marks around the reservoir that were left in place after the construction of the dams was completed.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The natural slopes along the east and southwest shores, are quite gentle, some bedrock is exposed here and there along the east shore, portions of the slopes are lined with dumped stones for protection. About one-third of the shore line is formed by the dam embankments and is well protected by paved riprap. The overall stability of the shore is excellent.	
SEDIMENTATION	The reservoir itself is fed from the northern lakes through the transmission pipes. There is no natural drainage into the reservoir. A small amount of sediments may be derived from the erosion at the unprotected natural ground surface around the shoreline, especially between the high and low water levels. The soils of the original ground are mainly fine sandy silt (ML) to silty sand (SM) with variable sized gravels.	

APPENDIX B

ENGINEERING DATA LIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available at City of Newark, Div. of Water Supply
REGIONAL VICINITY MAP	Available at City of Newark, Div. of Water Supply
CONSTRUCTION HISTORY	Not Available
TYPICAL SECTIONS OF DAM	1. West dam: U/S - 2 horizontal:1 vertical with 8-foot wide upper berm and lower berm of variable width, riprap paved; D/S - 2 horizontal:1 vertical with 8-foot wide upper berm and lower berm of variable width, grass protected, crest width - 18 feet. 2. North dam: U/S - 2 horizontal:1 vertical, riprap paved. D/S - 2 horizontal:1 vertical, grass protected, crest width - 16 feet. 3. South dam: U/S - 2 horizontal:1 vertical, with berm of variable width, riprap paved D/S - 2 horizontal:1 vertical, with berm of variable width, grass protected Crest width - 12 feet.
HYDROLOGIC/HYDRAULIC DATA	
OUTLETS - PLAN	Attached in this report, see Figure 5.
- DETAILS	Attached in this report, see Figure 5.
- CONSTRAINTS	Water will not flow through the spillway as long as the water level is below elevation 405 feet.
- DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Daily readings of water levels in the reservoir are kept in file. Rainfall data is not gathered at the reservoir; however, the water supply company takes daily readings at three rainfall recording stations throughout their watershed (at Canister Reservoir, Charlotteburg Reservoir, and Clinton Reservoir). The rainfall records are published in their annual report and also sent monthly to the Division of Water Resources of the DEP office in Trenton, New Jersey.

CHECK LIST (cont'd.)

ITEM	REMARKS
DESIGN REPORTS	Not available.
GEOLOGY REPORTS	Not available.
DESIGN COMPUTATIONS	Not available.
HYDROLOGY & HYDRAULICS	Not available.
DAM STABILITY	Not available.
SEEPAGE STUDIES	Not available.
MATERIALS INVESTIGATIONS	Not available.
BORING RECORDS	Not available.
LABORATORY	Not available.
FIELD	Not available.
POST-CONSTRUCTION SURVEYS OF DAM	Not available, but some of record drawings showing the cross sections are available at Dept. of Water, Newark, N. J.
BORROW SOURCES	Not available.
SPILLWAY PLAN	The spillway as constructed differs from the record drawings.
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	No information available, except sluice gates sizes noted on record drawing.
MONITORING SYSTEMS	None.
MODIFICATIONS	None.

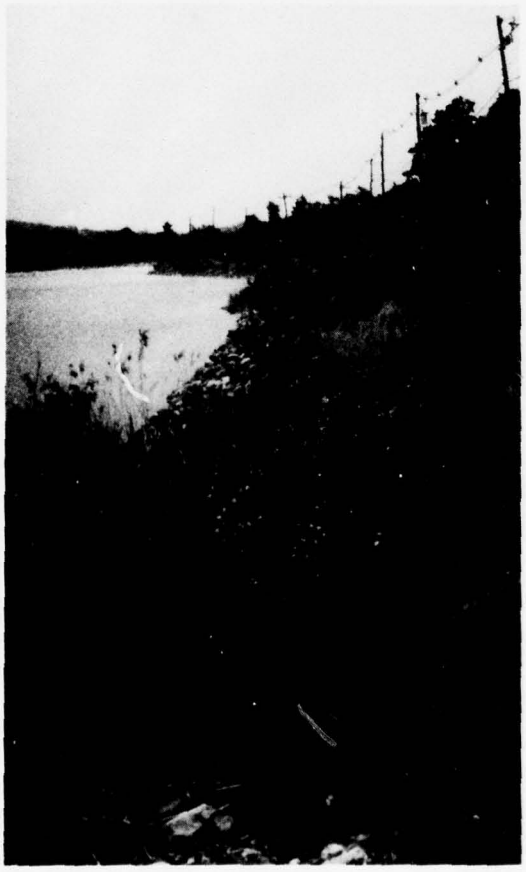
CHECK LIST (cont'd.)

ITEM	REMARKS
HIGH POOL RECORDS	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None.
MAINTENANCE OPERATION RECORDS	None.

APPENDIX C

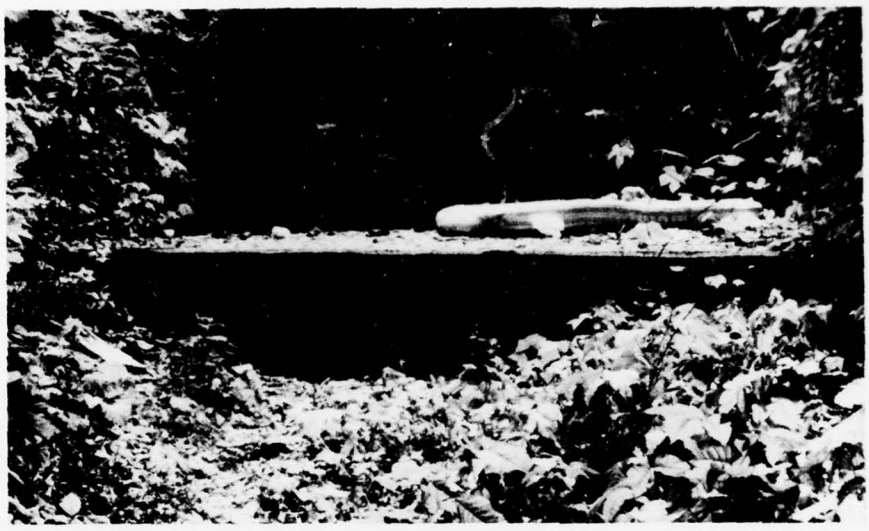
PHOTOGRAPHS

UPSTREAM VIEW OF CREST DAM



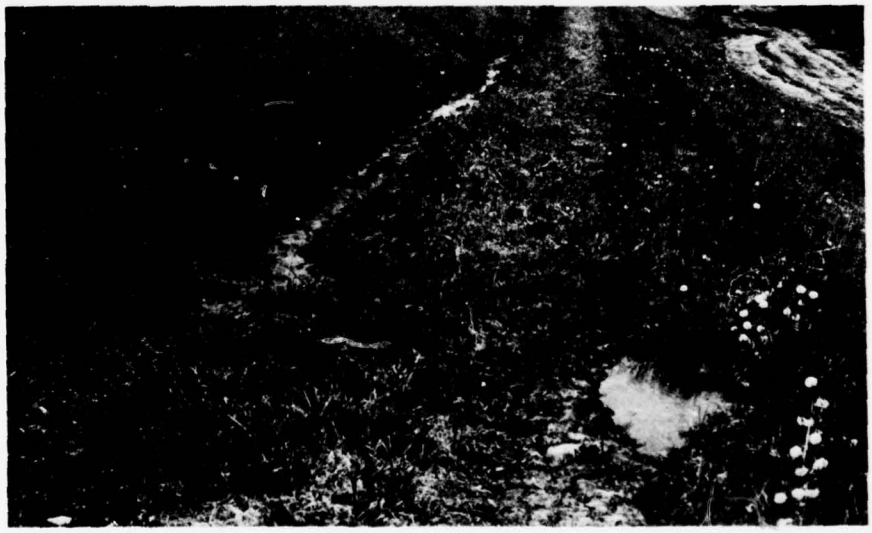
WEST SHORELINE OF RESERVOIR
BETWEEN WEST AND SOUTH DAM

May 1978



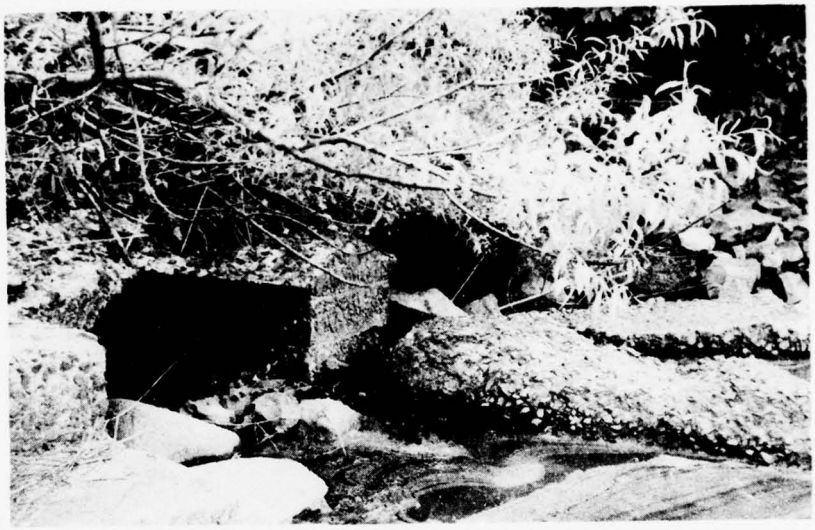
May 1978

OVERFLOW WEIR



May 1978

ONLY WET SPOT ON DOWNSTREAM SLOPE OF WEST DAM



May 1978

INLET TO EMERGENCY SPILLWAY

APPENDIX D

HYDRAULIC COMPUTATIONS

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

CLIENT: Corps of Eng.
PROJECT: DAM INSPECTION

FILING CODE

W.O. | PAGE 1 OF

SYSTEM: CEDAR GROVE

ORIGINATOR: Wahanik PRR
DATE: July 26/78

CALCULATION FOR: RESERVOIR DRAWDOWN

REVIEWER: D.O. VEIL PRR
DATE: 7-28-78

RESULTS

The volumes of the reservoir were given to us in million gallons of storage and the information starts at elevation 365. (See table "Capacity Table of Cedar Grove Reservoir". Supplied by Mr. Jim Conley of the City of Newark.)

WATER ELEVATION FEET	STORAGE OF THE RESERVOIR			DIFFERENCE BETWEEN WATER LEVELS ft.³
	MILLION GALLONS	Acre-ft	ft.³	
365	32.011	98.24	4,279,254	
				3,666,060
370	59.435	182.40	7,945,314	
				4,987,094
375	96.741	296.89	12,932,408	
				6,315,211
380	143.982	441.86	19,247,619	
				7,675,279
385	201.397	618.06	26,922,898	
				11,487,854
390	287.332	881.79	38,410,752	
				15,162,469
395	400.755	1229.87	53,573,221	
				17,748,874
400	533.527	1637.33	71,322,095	
				19,401,002
405	678.655	2082.72	90,723,097	

Inflow contribution for 100 Acres of D.A. is meaningless!

1 Acre-ft. = 43,560 ft.³
1 Acre-ft. = 325,851 Gallons
Centerline of 48" discharge is 355.'

FILING CODE

GAI 350 REV. 10-72

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

CLIENT: Corps of Eng.
PROJECT: DAM INSPECTION
FILING CODE
W.O. 7249 | PAGE 2 of
SYSTEM: CEDAR GROVE
ORIGINATOR: Wahanik PRR
DATE: July 20/78
CALCULATION FOR: RESERVOIR DRAWDOWN
REVIEWER: D. VEIL PRR
DATE: 7-28-78
RESULTS

The Cedar Grove Reservoir can be drained by means of a 48" diameter reinforced concrete pipe. Since this pipe has been there for 70 years it will be assumed that it will have a Manning "n" of 0.024.

$L_{48"} = 220 + 350 + 800 = 1370'$

Miner Losses
Entrance valve with reduction $K = 0.5$
2 elbows 90° each K of two elbows $= 0.5$
other losses $K = 1.00$

$$Q = a\sqrt{\frac{2gh}{1+K_m+K_pL}} \quad a\sqrt{\frac{64.4h}{1+K_m+K_pL}}$$

$a = 12.57$
$1+K_m = 3.00$
$K_p = 0.0168$
$K_pL = 0.0168 \times 1370 = 23.016$

$$Q = 12.57\sqrt{\frac{64.4}{26.016}h} = 12.57\sqrt{2.475}\sqrt{h}$$

$$Q = 19.777\sqrt{h}$$

FILING CODE

GAI 350 REV. 10-72

DRAWDOWN TIME WITHOUT CONSIDERING WATER DEMAND OR INFLOW FROM UPSTEAM RES.

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

CLIENT: Corps. of Eng.
PROJECT: DAM INSPECTION
FILING CODE
W.O.
PAGE: 3 OF
SYSTEM: CEDAR GROVE
ORIGINATOR: Wahan. K PRR
DATE: July 20/78
CALCULATION FOR: DRAWDOWN
REVIEWER: O. Veil PRR
DATE: 7-28-78
RESULTS

WATER LEVEL FEET	CENTER OF GRAVITY OF LAYER OF WATER	AVAILABLE HEAD (h) ABOVE 355 FT.	RESULTING Q IN CFS $9.777\sqrt{h}$	VOLUME OF WATER STORED BETWEEN THE WATER LEVELS CUBIC FEET	PARTIAL TIME TO EMPTY IN HOURS	TOTAL DRAWDOWN TIME HOURS
405	402.5	47.50	136.30	19,401,002	39.54	0
400	397.5	42.50	128.93	17,748,874	38.24	39.54
395	392.5	37.50	121.11	15,162,469	34.78	77.78
390	387.5	32.50	112.75	11,487,854	28.30	112.56
385	382.5	27.50	103.71	7,675,279	20.56	140.86
380	377.5	22.50	93.81	6,315,211	18.70	161.42
375	372.5	17.50	82.73	4,987,094	16.74	180.12
370	367.5	12.50	69.72	3,666,060	14.61	196.86
365	360.0	5.00	44.22	4,279,254	26.88	211.47
355						238.35

FILING CODE

GAI 350 REV. 10-72

GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.	CLIENT: Corps of Eng.	FILING CODE
	PROJECT: DAM INSPECTION	W.O. / PAGE 4 OF
SYSTEM: CEDAR GROVE		ORIGINATOR: Wahanik PRR DATE July 20/78
CALCULATION FOR: DRAWDOWN		REVIEWER: D. Veil PRR DATE 7-28-78

RESULTS

With a water demand of 75 MGD concurrent with the reservoir drawdown the times required are to be corrected by the amount $-\left(\frac{116.04 \text{ cfs}}{Q \text{ cfs}}\right)$

WATER LEVEL	ACCUMULATED DRAWDOWN TIME (HOURS)	CORRECTION FACTOR (NEGATIVE)	TOTAL ACCUMULATED DRAWDOWN TIME USED IN REPORT (HOURS)
405	0	0	0
400	39.54	-0.85	38.69
395	77.78	-0.90	76.88
390	112.56	-0.96	111.60
385	140.86	-1.03	139.83
380	161.42	-1.12	160.30
375	180.12	-1.24	178.88
370	196.86	-1.40	195.46
365	211.47	-1.66	209.81
355	238.35	-2.62	235.73

FILING CODE

GAI 350 REV. 10-72

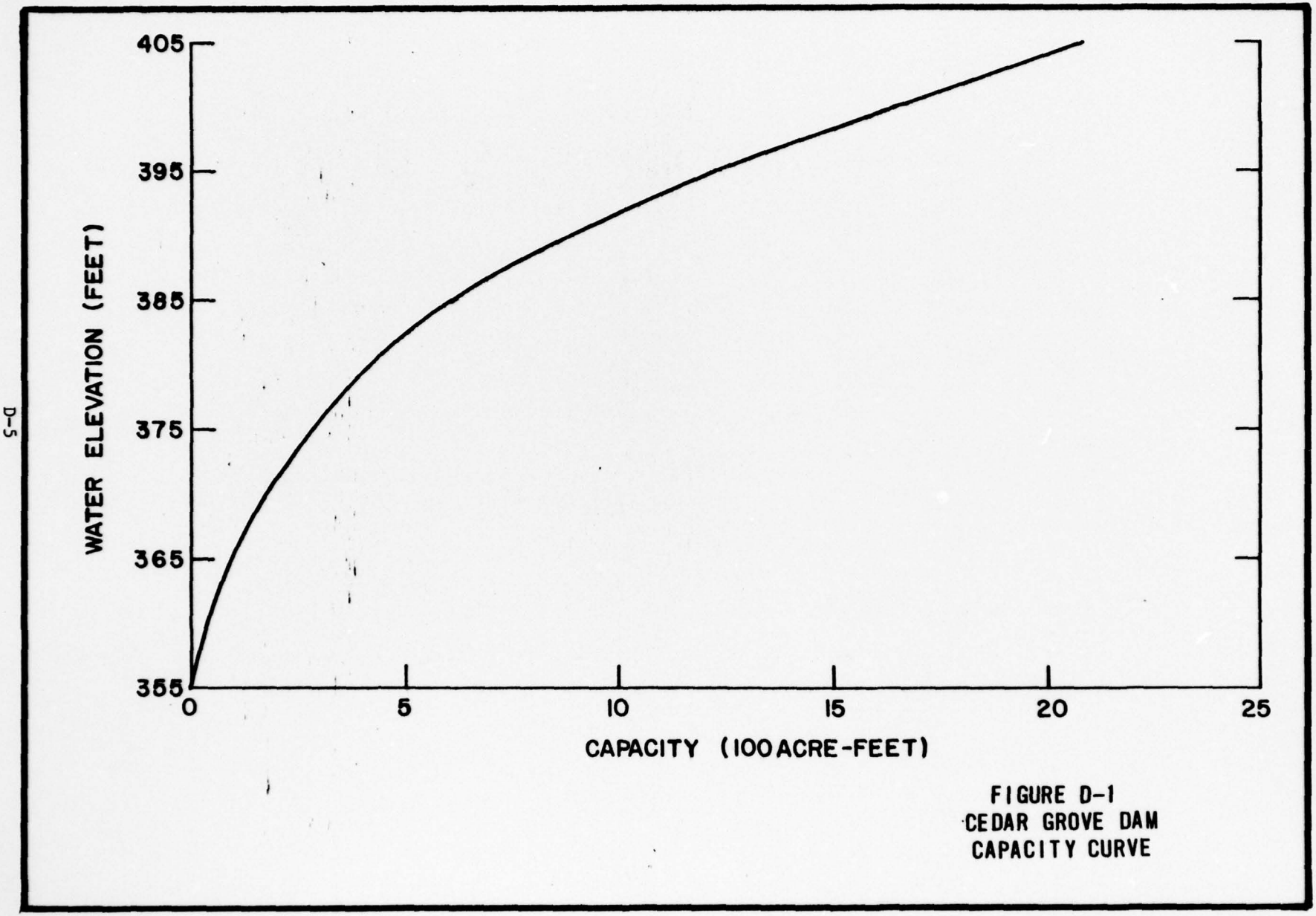


FIGURE D-1
CEDAR GROVE DAM
CAPACITY CURVE

APPENDIX E

U.S. CORPS OF ENGINEERS' RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS

recommended guidelines for safety dam inspection of DAMS

DEPARTMENT OF THE ARMY • OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON D C 20314

Reclamation and Soil Conservation Service. Many other agencies, educational facilities and private consultants can also provide expert advice. Regardless of where such expertise is based, the qualification of those individuals offering to provide it should be carefully examined and evaluated.

4.3.4. Freeboard Allowances. Guidelines on specific minimum freeboard allowances are not considered appropriate because of the many factors involved in such determinations. The investigator will have to assess the critical parameters for each project and develop its minimum requirement. Many projects are reasonably safe without freeboard allowance because they are designed for overtopping, or other factors minimize possible overtopping. Conversely, freeboard allowances of several feet may be necessary to provide a safe condition. Parameters that should be considered include the duration of high water levels in the reservoir during the design flood; the effective wind fetch and reservoir depth available to support wave generation; the probability of high wind speed occurring from a critical direction; the potential wave runup on the dam based on roughness and slope; and the ability of the dam to resist erosion from overtopping waves.

4.4. Stability Investigations. The Phase II stability investigations should be compatible with the guidelines of this paragraph.

4.4.1. Foundation and Material Investigations. The scope of the foundation and materials investigation should be limited to obtaining the information required to analyze the structural stability and to investigate any suspected condition which would adversely affect the safety of the dam. Such investigations may include borings to obtain concrete, embankment, soil foundation, and bedrock samples; testing specimens from these samples to determine the strength and elastic parameters of the materials, including the soft seams, joints, fault gouge and expansive clays or other critical materials in the foundation; determining the character of the bedrock including joints, bedding planes, fractures, faults, voids and caverns, and other geological irregularities; and installing instruments for determining movements, strains, suspected excessive internal seepage pressures, seepage gradients and uplift forces. Special investigations may be necessary where suspect rock types such as limestone, gypsum, salt, basalt, claystone, shales or others are involved in foundations or abutments in order to determine the extent of cavities, piping or other deficiencies in the rock foundation. A concrete core drilling program should be undertaken only when the existence of significant structural cracks is suspected or the general qualitative condition of the concrete is in doubt. The tests of materials will be necessary only where such data are lacking or are outdated.

4.4.2. Stability Assessment. Stability assessments should utilize in situ properties of the structure and its foundation and pertinent geologic

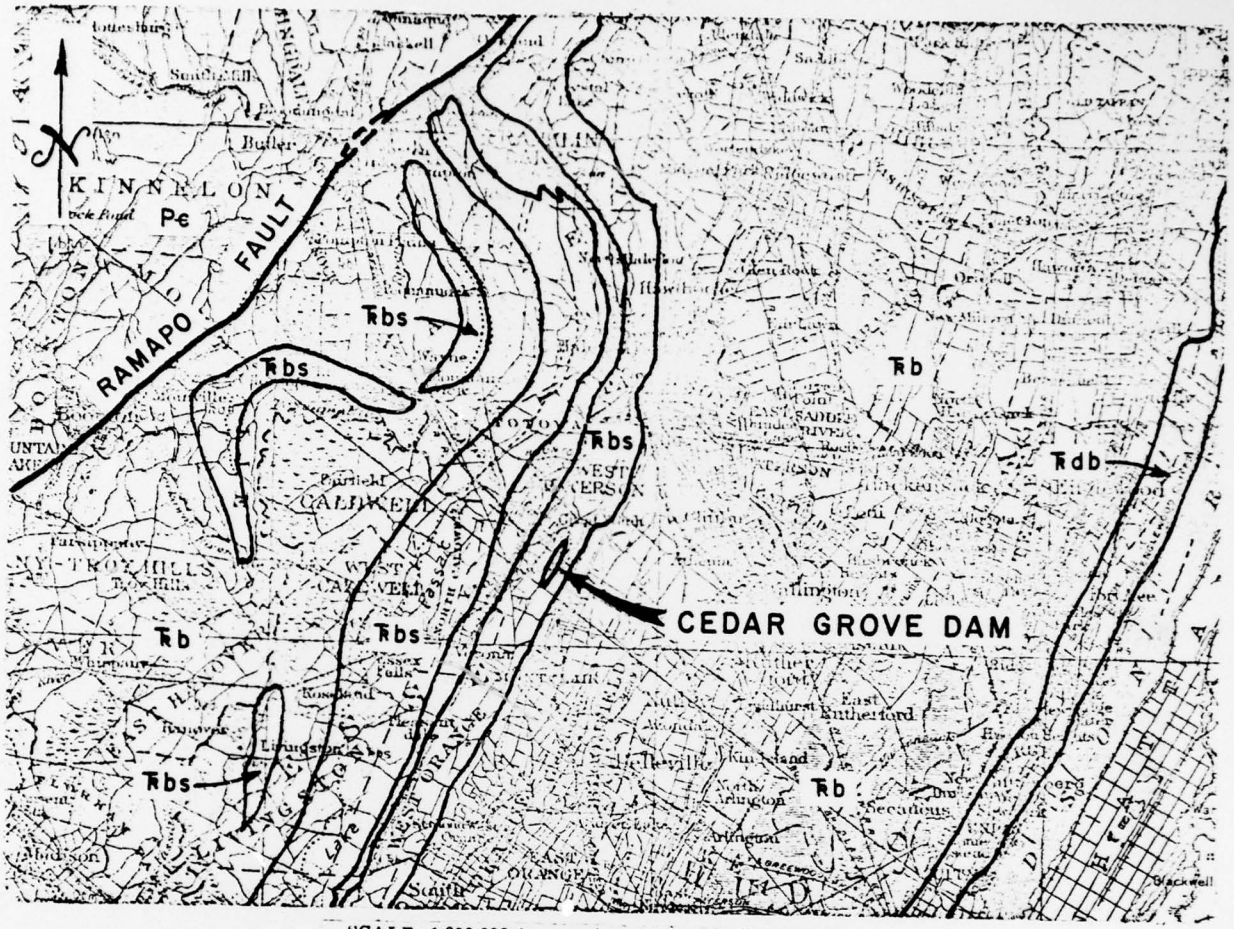
information. Geologic information that should be considered includes groundwater and seepage conditions; lithology, stratigraphy, and geologic details disclosed by borings, "as-built" records, and geologic interpretation; maximum past overburden at site as deduced from geologic evidence; bedding, folding and faulting; joints and joint systems; weathering; slickensides, and field evidence relating to slides, faults, movements and earthquake activity. Foundations may present problems where they contain adversely oriented joints, slickensides or fissured material, faults, seams of soft materials, or weak layers. Such defects and excess pore water pressures may contribute to instability. Special tests may be necessary to determine physical properties of particular materials. The results of stability analyses afford a means of evaluating the structure's existing resistance to failure and also the effects of any proposed modifications. Results of stability analyses should be reviewed for compatibility with performance experience when possible.

4.4.2.1. Seismic Stability. The inertial forces for use in the conventional equivalent static force method of analysis should be obtained by multiplying the weight by the seismic coefficient and should be applied as a horizontal force at the center of gravity of the section or element. The seismic coefficients suggested for use with such analyses are listed in Figures 1 through 4. Seismic stability investigations for all high hazard category dams located in Seismic Zone 4 and high hazard dams of the hydraulic fill type in Zone 3 should include suitable dynamic procedures and analyses. Dynamic analyses for other dams and higher seismic coefficients are appropriate if in the judgment of the investigating engineer they are warranted because of proximity to active faults or other reasons. Seismic stability investigations should utilize "state-of-the-art" procedures involving seismological and geological studies to establish earthquake parameters for use in dynamic stability analyses and, where appropriate, the dynamic testing of materials. Stability analyses may be based upon either time-history or response spectra techniques. The results of dynamic analyses should be assessed on the basis of whether or not the dam would have sufficient residual integrity to retain the reservoir during and after the greatest or most adverse earthquake which might occur near the project location.

4.4.2.2. Clay Shale Foundation. Clay shale is a highly overconsolidated sedimentary rock comprised predominantly of clay minerals, with little or no cementation. Foundations of clay shales require special measures in stability investigations. Clay shales, particularly those containing montmorillonite, may be highly susceptible to expansion and consequent loss of strength upon unloading. The shear strength and the resistance to deformation of clay shales may be quite low and high pore water pressures may develop under increase in load. The presence of slickensides in clay shales is usually an indication of low shear stength. Prediction

APPENDIX F

REGIONAL GEOLOGIC MAP



Trb — **TRIASSIC (NEWARK GROUP) BRUNSWICK FORMATION**

SOFT RED SHALE WITH SANDSTONE BEDS, THE LATTER MORE ABUNDANT TOWARD THE NORTHEAST; CONGLOMERATE BEDS (TRC) ALONG NORTHWESTERN BORDER WITH QUARTZITE OR LIMESTONE PEBBLES IN RED MATRIX.

Trbs — **TRIASSIC (NEWARK GROUP) BASALT FLOWS**

FINE-GRAINED TRAP ROCK IN EXTENSIVE FLOWS, CHIEFLY IN THE WATCHUNG MOUNTAINS: IN PART VESICULAR.

Trdb — **DIABASE**

COARSE-GRAINED TRAP ROCK, CHIEFLY INTRUSIVE SHEETS IN THE NEWARK FORMATIONS. ALSO DIKES, A FEW BASALTIC (Trbs)

Pε — **PRECAMBRIAN**

UNDIFFERENTIATED (GNEISS, GRANITE, AMPHIBOLITE, ETC.)

SOURCE: GEOLOGIC MAP OF NEW JERSEY, ATLAS SHEET 40 1910 – 1912

APPENDIX F – REGIONAL GEOLOGIC MAP

APPENDIX G

REFERENCES

APPENDIX G

REFERENCES

1. Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian, U.S. Weather Bureau, Hydrometeorological Report No. 33, April 1956.

2. Recommended Guidelines for Safety Inspection of Dams, Department of the Army, Office of the Chief of Engineers, Washington, D.C.

3. History of the Water Supply of the City of Newark, New Jersey.

4. Design of Small Dams, Bureau of Reclamation, 2nd Edition.

APPENDIX H

CONDITIONS

APPENDIX H

CONDITIONS

This report is based on a visual inspection of the dam, a review of available engineering data, and a hydrologic analysis performed during Phase I investigation as set forth in the Recommended Guidelines for Safety Inspection of Dams, as modified by the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc., Contract No. DACW61-78-C-0114.

The foregoing review, inspection, and analysis are by their nature limited in scope. It is possible that hazardous conditions exist and that conditions exist which with time might develop into safety hazards and that these conditions are not detectable by means of the aforesaid review, inspection, and analysis. Accordingly Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous do not exist, or that conditions do not exist which with time might develop into safety hazards.

As required by the Corps of Engineers, the terms "good", "fair", "poor", "condition" have been used in this report to characterize the information obtained from the aforesaid review, inspection, and analysis. The definitions of these terms as used are:

"good condition" - minor studies or remedial measures are required.

"fair condition" - sizeable studies or remedial measures are required due to the deficiencies which could be hazardous depending on conditions. Immediate attention is required.

"poor condition" - major studies or remedial measures are required due to deficiencies which could be hazardous depending on conditions. Immediate studies or corrective action is required.